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14. ABSTRACT

An acoustical evaluation of the engine test cell facilities at Misawa AB, Japan, was performed in December 2012. This assessment was accomplished to help determine overall sound pressure levels during multiple power settings of aircraft engine run-up procedures. It was determined that personnel performing these duties are exposed to hazardous noise levels. Therefore, it was recommended that engine test cell facilities should remain labeled as hazardous noise areas, personnel should be enrolled in the hearing conservation program and receive audiograms, and noise dosimetry should be performed to better characterize the cumulative noise exposures.

15. SUBJECT TERMS
Octave band analysis, hazardous noise, engine test cell, F-16, GE F110-100, GE F110-129, hearing, acoustics, noise

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DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

25 March 2013

MEMORANDUM FOR 35 AMDS/SGPB
ATTN: MAJ ALLMANN
UNIT 2060
APO AP 96278

FROM: USAFSAM/OEC
2510 Fifth Street
Wright-Patterson AFB, OH 45433

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2013-0006, Acoustical Evaluation of Engine Test Cell Facility at the 35th Maintenance Squadron (MXS/MXMPT), Misawa AB, Japan

1. INTRODUCTION:

a. *Purpose*: On 10-14 December 2012, the United States Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC) and USAFSAM Detachment 3 (DET 3-USAFSAM/CD), at the request of 35 AMDS/SGPB, conducted an acoustical evaluation of the 35 MXS/MXMPT engine test cell (ETC). This assessment was accomplished to help determine overall sound pressure levels (SPLs) during multiple power settings of aircraft engine run-up procedures. Noise assessment data were collected during an F-16 run-up in Bldg 1208. In addition, two separate, stand-alone engines, a GE F110-129 and a GE F110-100, were run in Bldg 3008.

b. *Survey Personnel*:

(1) Flight Chief, Consultation Division, DET 3-USAFSAM/CD
(2) Industrial Hygiene Consultant, USAFSAM/OECM
(3) Industrial Hygiene Consultant, USAFSAM/OECM

c. *Personnel Contacted*:

(1) Flight Chief, Bioenvironmental Engineering, 35 AMDS/SGPB
(2) Bioenvironmental Engineer, 35 AMDS/SGPB
(3) Engine Test Cell Section Chief, 35 MXS/MXMPT
(4) Aerospace Propulsion Craftsman, 35 MXS/MXMPT
(5) Aerospace Propulsion Craftsman, 35 MXS/MXMPT
(6) Aerospace Propulsion Journeyman, 35 MXS/MXMPT

d. *Equipment*:

(1) Norsonic Real Time Analyzer, Type RTA 840, SN 18701
(2) B&K Sound Level Calibrator, Type 4231, SN 2422533
(3) Larson Davis Microphone Pre-Amplifier Power Supply, Type 2221, SN 0135, 3824, 3826
(4) Larson Davis Microphone, Type 2221, SN 1485, 1489, 1492
(5) Larson Davis Microphone Pre-Amplifier, Type 902, SN 0200, 0202, 0203

2. METHODOLOGY:

a. Noise measurements were taken in the bay area (at a height 5 feet above the floor) where the aircraft engines were placed, in the observation rooms (at a height 5 feet above the floor), and in the engine run cab (at a height 3.5 feet above the floor) where ETC personnel were located. All measurements were collected at three separate engine power levels: (1) engine at idle, (2) military power (MIL), and (3) augmentation (afterburner). During one power level (idle leak checks) in the bay, measurements were taken at individuals' ear level.

b. SPL data were collected using a Norsonic Real-Time Analyzer (RTA) Nor-840 with a ¼-inch microphone connected to each of the two input channels. The RTA was set to slow response. The RTA measured the full octave bands, equivalent overall SPLs for given times of exposure, and the equivalent overall A-weighted SPLs for the times of exposure.

c. These noise measurements were used to determine if the in-place engineering controls (two observation rooms) and personnel protective equipment (David Clark communication headset) effectively controlled exposures to hazardous noise.

3. RESULTS:

a. The overall average SPLs for each sampling event and the corresponding equipment (F-16 or engine on test stand) are listed in Table 1, as well as the respective operating power settings for the aircraft or engine with the location of the microphone for each measurement. Daily calculated unprotected allowable exposure times were limited to 1440 minutes in Table 1.

b. The attachment to this report lists each individual sampling event's octave band analysis results that can be used to assist in selecting adequate hearing protection.

Table 1. Overall Average SPLs in the Engine Test Cell

Noise Source	Microphone Location	Power Setting/Activity	Overall SPL [dB(A)]	Unprotected Allowable Exposure Time (min)
F-16	**ETC Bay**[a]	Idle	105.2	4
		MIL Power	124.1	0
		Augmentation	127.1	0
		Idle Leak Check	**120.3**	**0**
	Observation Rm 1[a]	**Idle**	**99.9**	**15**
GE F110-100	**ETC BAY**[a]	Idle	115.8	0
		MIL Power	140.0	0
		Augmentation	143.6	0
		Idle Leak Check	**118.0**	**0**
	Observation Rm 1	Idle	64.3	1440
		MIL Power	80.3	1421[b]
		Augmentation	83.7	648[b]
	Observation Rm 2	Idle	53.3	1440
	Engine Run Cab	Idle	72.2	1440
		MIL Power	72.6	1440
		Augmentation	75.4	1440
GE F110-129	**Observation Rm 1**[a]	Idle	76.8	1440
		MIL Power	71.2 78.5[c] **88.8**[c]	**199**
		Augmentation	70.2 82.4	875[b]
		Idle Leak Check	74.4	1440
	ETC Bay[a]	MIL Power	100.1 142.8	0
		Augmentation	94.6 140.4	0
		Idle Leak Check	**118.6** **129.3**	**0**

[a]Bold indicates personnel are exposed to noise levels >85 dB(A).
[b]Exposure of more than 12 hours to this level needs to be followed by equal length in quiet (<72 dBA).
[c]These readings were elevated due to ETC personnel opening the observation room door while an engine was running.

4. DISCUSSION:

a. Table 1, above, lists the allowable unprotected exposure times for each noise source setting observed for ETC personnel while performing duties in the engine run-up bay while an engine is operating. If a noise source has more than one reading, the unprotected allowable exposure time was calculated based on highest overall SPL.

b. SPL data indicate that the existing engineering controls (observations rooms and operator cab) provide sufficient protection from hazardous noise during stand-alone engine run procedures. The overall SPL inside the observation room for the F-16 at idle power setting was measured at 99.9 dB(A).

c. The at-ear attenuation of the David Clark communication headset was calculated to determine the amount of protection ETC personnel receive while performing duties in the engine bay while an engine is running. Calculations were performed based upon the data obtained from idle leak checks. The overall reduction levels were as follows: GE F110-129 was reduced from 129.3 to 94.7 dB(A) with an allowable exposure time of 51 minutes, the GE F110-100 was reduced from118.0 to 80.6 dB(A) with an allowable exposure time of 1326 minutes, and the F-16 was reduced from 120.3 to 93.8 dB(A) with an allowable exposure time of 62 minutes.

5. RECOMMENDATIONS:

a. The engine test cell facilities should remain labeled as hazardous noise areas in accordance with AFOSH Standard 48-20, para 3.1.4.

b. Based on the results and the observed variability in overall SPLs at the different locations, it is likely that 35 MXS/MXMPT personnel are routinely exposed to >85 dBA as an 8-hour time-weighted average. In accordance with AFOSH Standard 48-20, para 3.6.3.2.6, USAFSAM/OEC recommends that all personnel who are assigned to conduct engine run-up duties should be enrolled in the hearing conservation program and receive audiograms.

c. All 35 MXS/MXMPT personnel should be trained about the risk of hearing loss and their ability to reduce unnecessary exposures to running jet engines.

d. 35 MXS personnel who perform duties in the ETC should maximize their time spent in the observation room or the engine run cab with the doors closed while a jet engine is running.

e. Noise dosimetry should be performed to better characterize the cumulative noise exposures to 35 MXS/MXMPT personnel.

6. We greatly appreciated the assistance of the 35 AMDS and 35 MXS in accomplishing this assessment. If you have any further questions regarding this report, please contact TSgt Jerimiah Jackson at DSN 798-3312 or jerimiah.jackson@us.af.mil. Please direct any questions or comments regarding Industrial Hygiene Consultative support to Lt Col Sonntag at DSN 798-3328 or david.sonntag@us.af.mil. To improve our services, please complete and return the critique provided with this report.

JERIMIAH M. JACKSON, TSgt, USAF
Industrial Hygiene Consultant

Attachment:
Misawa Air Base Engine Test Cell Octave Band Analysis

Attachment
Misawa Air Base Engine Test Cell
Octave Band Analysis

System and Power Setting	Microphone Location	Sample Duration (mm:ss)	Frequency (Hz)									
			31.5	63	125	250	500	1K	2K	4K	8K	16K
F-16 – Idle	ETC Bay	13:31	93.8	103.6	100.3	99.0	99.6	99.1	96.7	96.2	97.4	101.1
F-16 – MIL Power	ETC Bay	3:59	97.5	114.3	111.8	114.2	119.0	118.2	117.7	115.6	113.0	110.9
F-16 - Augmentation	ETC Bay	3:21	92.3	107.4	110.0	114.6	120.7	121.4	121.1	119.1	116.2	114.0
F-16 – Idle Leak Check	ETC Bay	2:23	97.5	116.2	111.2	108.3	113.4	114.3	114.4	112.6	109.7	122.3
F-16 – Idle	Observation Rm 1	5:01	97.4	116.2	110.6	101.6	95.4	88.5	83.6	82.9	79.9	82.5
GE F110-129 – Idle	Observation Rm 1	1:00	76.9	66.9	66.1	71.4	74.6	70.7	66.6	68.8	64.7	70.3
GE F110-129 – MIL Power	Observation Rm 1	4:44	70.3	88.4	81.2	72.2	66.2	61.2	54.4	52.9	55.5	67.2
GE F110-129 – Augmentation	Observation Rm 1	1:08	69.6	87.2	80.1	71.0	65.0	59.9	54.1	53.1	55.8	67.0
GE F110-129 – MIL Power	Observation Rm 1	1:02	93.4	88.6	85.7	85.2	74.2	64.1	56.7	54.5	51.0	42.5
GE F110-129 – MIL Power	ETC Bay	1:01	98.5	113.8	108.5	100.2	96.1	93.0	88.9	86.0	83.9	79.5
GE F110-129 – Augmentation	Observation Rm 1	1:01	99.8	92.6	90.4	88.9	78.4	69.7	61.1	58.8	55.3	46.4
GE F110-129 – Augmentation	ETC Bay	1:00	103.6	96.3	95.4	91.9	88.3	87.1	87.0	86.7	87.8	79.9
GE F110-129 – Idle Leak Check	Observation Rm 1	4:42	69.9	69.1	65.2	64.8	74.5	67.6	65.3	62.1	46.5	43.1
GE F110-129 – Idle Leak Check	ETC Bay	4:42	92.5	98.9	107.7	108.5	112.6	116.0	124.6	123.3	120.8	122.2
GE F110-129 – MIL Power Leak Check	Observation Rm 1	1:00	98.2	90.5	90.4	88.0	83.6	81.4	80.0	80.5	81.9	74.9
GE F110-129 – Idle Leak Check	ETC Bay	1:01	98.3	116.6	112.2	104.1	104.5	106.3	111.8	113.5	109.7	114.0
GE F110-129 – MIL Power	ETC Bay	1:00	104.0	111.9	124.0	128.7	135.2	137.2	137.2	134.7	131.5	128.7
GE F110-129 – Augmentation	ETC Bay	00:59	121.8	126.7	130.1	132.4	133.7	134.3	133.9	132.8	131.0	129.0
GE F110-100 – Idle	Observation Rm 1	6:06	68.6	62.8	59.2	57.0	61.1	57.3	59.5	52.0	47.1	48.9
GE F110-100 – Idle	Observation Rm 2	6:06	80.6	63.9	58.1	54.3	42.5	41.0	44.5	44.8	47.0	50.2
GE F110-100 – MIL Power	Observation Rm 1	5:43	98.4	87.7	85.4	89.5	68.5	60.2	58.6	58.2	60.1	55.6
GE F110-100 – Augmentation	Observation Rm 1	1:03	103.6	92.7	91.1	92.4	72.6	66.7	66.0	65.1	66.6	61.0
GE F110-100 – Idle	ETC Bay	1:02	90.7	85.4	95.3	93.5	94.9	97.1	113.9	103.4	101.4	106.1
GE F110-100 – MIL Power	Engine Run Cab	1:02	64.1	73.9	67.2	72.2	73.8	62.3	60.4	58.7	52.5	49.4
GE F110-100 – MIL Power	ETC Bay	1:01	114.1	119.0	126.5	129.2	133.2	135.3	133.5	131.5	128.2	125.3
GE F110-100 – Idle	Engine Run Cab	1:01	81.8	78.2	81.1	79.1	64.8	63.2	56.5	56.3	55.0	56.3
GE F110-100 – Augmentation	ETC Bay	1:00	119.7	122.7	128.5	131.7	135.9	137.9	137.6	135.9	132.8	130.1
GE F110-100 – Augmentation	Engine Run Cab	1:00	94.6	87.7	81.7	85.7	81.8	65.8	67.6	56.6	58.3	65.6
GE F110-100 – Idle Leak Check	ETC Bay	2:59	100.5	98.9	99.5	95.6	97.5	99.8	115.7	108.0	106.0	107.5